



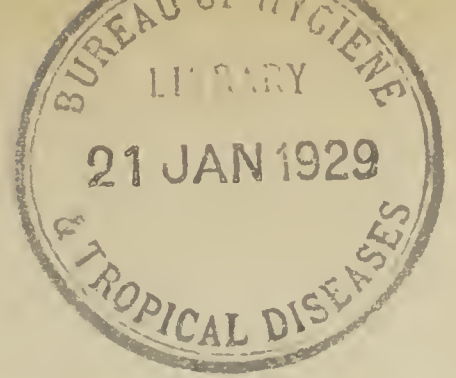
ANNUAL REPORT

OF THE

VETERINARY DEPARTMENT

SUDAN GOVERNMENT.

1927.



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ANNUAL REPORT.

VETERINARY DEPARTMENT, SUDAN GOVERNMENT, 1927.

STAFF.

Major R. H. Knowles, Royal Army Veterinary Corps, who held the appointment of Veterinary Research Officer, reverted to the British Army on 31st March.

Mr. S. C. J. Bennett, the Assistant Veterinary Research Officer was appointed Veterinary Research Officer with effect from 31st March

Mr. C. W. Pembrey was appointed Veterinary Inspector with effect from the 14th November.

Veterinary Inspectors were stationed in the Provinces of Khartoum, Kassala, Blue Nile, Kordofan, Darfur and Halfa throughout the year, and tours were made in the Provinces of Berber, Fung, White Nile, Nuba Mountains and the Upper Nile.

The Assistant Director toured for over three months in the Provinces of Kordofan and Darfur and he also visited Malakal. The Director made a short tour in the Nuba Mountains Province and also visited Wad Medani and Wadi Halfa at different times during the year.

SECTION I.

DISEASES OF ANIMALS.

1. Diseases of Cattle.

As a result of two years of poor rainfall the adverse conditions referred to in last year's report in regard to grazing and water obtained in a somewhat greater degree throughout the northern and central Sudan during the first half of the year. The consequent congestion of stock in areas possessing permanent water supplies favoured the spread of infectious and contagious diseases and the losses suffered from rinderpest and pleuro-pneumonia were again considerable. Losses from other diseases do not appear to have been abnormal but the mortality amongst young stock owing to the scarcity of grazing was greater than usual.

It is gratifying to note that cattle owners generally are showing more appreciation of the efforts made to control stock diseases and the assistance rendered to this Department by the various tribal Chiefs concerned has in many cases proved of the greatest value.

Rinderpest.

Outbreaks of rinderpest were reported from all Provinces with the exceptions of Halfa and Dongola, but the heaviest losses were recorded in Darfur, Kordofan, Kassala, and the southern portion of the Red Sea Province. Of the total losses recorded fifty per cent. occurred in the first quarter and seventy per cent. in the first half of the year, but during the second half of the year the losses continued to be heavy in the provinces of Kassala, Fung, Nuba Mountains and White Nile.

The following figures for the past six years, compiled from reports received from provinces possessing a veterinary staff, although far from constituting a complete record of the losses caused by this disease, serve, nevertheless, for purposes of comparison :—

						Deaths.
1921-22	....	....	....	....	....	9,143
1922-23	....	....	....	....	....	9,164
1923-24	....	....	....	....	....	6,469
1924-25	....	....	....	....	....	3,757
1926	....	....	....	....	....	8,281
1927	....	....	....	....	....	8,629

No records are available for the Bahr-el-Ghazal, Mongalla and Upper Nile Provinces, but it is estimated that in all areas where the disease is enzootic and uncontrolled the average annual losses must approximate five per cent. of the total cattle population. When the disease recurs annually in a herd the losses are confined to the young stock and do not attract much attention, but if a herd which has escaped infection for three or four years is attacked, losses of from fifteen per cent. to twenty per cent. may be registered. In certain herds in Darfur where effective control was not possible a mortality of forty per cent. was recorded and enquiries showed that these herds had escaped infection for a period of about eight years.

Wherever possible anti-rinderpest serum was used in controlling outbreaks and altogether 10,500 doses were used as compared with 23,411 doses in 1926 and 14,030 doses in 1925. The serum used this year was obtained from the Veterinary Serum Institute in Cairo.

A system of regulating the numbers of cattle from the Western Sudan awaiting export at El Obeid, and of segregating such cattle until exported, was introduced in Kordofan Province and worked satisfactorily.

Forty-two cases of rinderpest occurred in the various quarantine stations as compared with two hundred and fifty-nine in the previous fifteen months.

No research work on rinderpest was carried out during the year as such investigations as are considered necessary can only be carried out economically in connection with the production of anti-rinderpest serum. A suitable site for the latter purpose has been selected in the Upper Nile Province and arrangements are being made to undertake such work in the near future.

Contagious Bovine Pleuro-pneumonia.

The losses recorded in 1927 in outbreaks of contagious bovine pleuro-pneumonia were as follows in the Provinces show :—

Province.			Deaths.
Kordofan	....	....	328
Kassala	....	....	151
White Nile	....	....	29
Blue Nile	....	....	27
Darfur	....	....	7
Total			542

As in the case of rinderpest these figures cannot be taken as an accurate reflection of the position in regard to this disease since, for example, no returns are available for the Bahr-el-Ghazal Province where the disease appears to be enzootic; they do, however, possess a value when compared with similar figures for previous years. The losses in 1924 were shown as eight hundred and eleven; in 1925 as eight hundred and twenty-nine; and in 1926 as one hundred and ninety-three. In the various quarantine stations seventy-eight cases of this disease came under notice during the year as compared with thirty-seven in 1926 and two hundred and forty-five in 1925. Kassala Province, which has been free of the disease for some years now, became infected in May and, as the disease appeared in herds which had been grazing along the Setit River in contact with the cattle of nomads from Eritrea, it is suspected that the infection originated in the latter. The vaccine produced at the Veterinary Research Laboratory against this disease was used freely and the position at the end of the year was distinctly more hopeful.

Infection has existed in Kordofan Province for some years now and the serious recrudescence of the disease which occurred this year is attributable to apparently healthy "carriers" of the disease coming

into close contact with large herds of susceptible cattle as a result of the congestion which occurred consequent on the scarcity of water and grazing. Some difficulty has been experienced in convincing owners that so-called recovered animals are a source of infection and should be destroyed but, as a result of a demonstration given at one of the Horse Shows held recently, this difficulty should no longer exist as far as the Homr tribe is concerned. The liberal use which has been made of vaccine in Kordofan should reduce further losses from this disease to a minimum.

The total number of doses of vaccine issued this year was 9,410 as against 4,250 during the previous year. This vaccine continues to give most satisfactory results but further research work has been carried out at the Veterinary Laboratory with a view to obtaining more information as to its efficiency and the duration of the immunity conferred. The details of this work are to be found in the appended report of the Veterinary Research Officer and the results of the experiments may be summarized as follows :—

- (a) The vaccine issued has been found to be safe and efficient and should produce a solid immunity in about two months.
- (b) The less time a virus has been kept in artificial culture the more rapidly it produces a solid immunity but very young cultures are too dangerous for ordinary use. Cultures of the seventeenth generation were found to be safe and to give good results whereas cultures of the 115th generation were found to be practically useless.
- (c) From one experiment carried out it seems likely that immunity in effectively immunized animals is still fairly strong at the end of two years but further experiments will be undertaken to ascertain the duration of the immunity conferred more definitely.

Anthrax and Foot-and-Mouth Disease.

No cases of anthrax or foot-and-mouth disease came under notice during the period under review.

Trypanosomiasis.

Trypanosoma congolense was diagnosed at the Veterinary Laboratory in blood smears forwarded from cattle from Malakal and Kosti, and *Trypanosoma vivax* in blood smears from cattle near Kosti, White Nile Province. A disease of cattle, known to the Rizeigat and Homr tribes as "Abu Nadir," which is stated to cause losses during or just after the rains, appears to be a form of trypanosomiasis and infection is probably contracted from tse-tse flies when the cattle are grazing on the Bahr-el-Arab. The tse-tse fly area in the Koaleib Hills, Nuba Mountains Province, attracted some attention during the year more particularly in connection with the use of animal transport. An Entomologist has been posted to the area to study the bionomics of the fly (*G. morsitans*) with a view to devising some means by which it may be exterminated. The trypanosomes pathogenic to the domesticated animals in that area are *T. congolense* and *T. brucei*.

It has not been found possible during the year to undertake any investigations into the trypanosomiasis of cattle in the vast tse-tse fly areas of the Southern Sudan.

II. Diseases of Camels.

It is estimated that the average number of camels for which forage allowance was drawn during 1927 was 1,830 and, of this number, three hundred and seventy-nine camels died from all causes or were cast as old and unfit for further service. This represents a total loss of 20.7 per cent. as compared with losses of 27.7 and 22.3 per cent. for the years 1925 and 1926 respectively. The camel-owning tribes do not appear to have suffered any abnormal losses during the period under review.

Trypanosomiasis.

Of the total losses referred to above, one hundred and four deaths, or 27.4 per cent., were returned as due to trypanosomiasis (*T. soudanense*). The returns for the year 1924-25 show the losses from this cause to have been 38.3 per cent. of the total losses from all causes so that the improvement registered last year in regard to this disease has been maintained. The returns for 1927 for Army camels, kindly supplied by the Military authorities, show that losses from trypanosomiasis amounted to 21.4 per cent. of the total losses as compared with 35.3 per cent. for the year 1924-25. This reduction in the mortality from trypanosomiasis is attributable to improved methods of diagnosis and to the use of "Naganol" as a curative agent. Four hundred and twenty-six doses of "Naganol" were issued during the year and much valuable research work has been and is being carried out at the Veterinary Laboratory with a view to a further improvement in the methods of diagnosis and to ascertaining the duration of immunity in cured camels.

An outbreak of trypanosomiasis, due to *T. congolense*, came under notice among camels employed in the tse-tse fly area of the Koaleib Hills, Nuba Mountains Province. It is believed that all the camels exposed to infection contracted the disease and died. An opportunity was taken to study this condition at the Veterinary Research Laboratory and the conclusions arrived at were that this trypanosome causes an acute disease in the camel which is more difficult to cure than *T. soudanense* infection.

A camel infected with *T. brucei* (*rhodesiense*) experimentally at the Laboratory was easily cured with a single dose of 10 grammes of "Naganol."

Fuller details of the research work carried out in connection with trypanosomiasis of the camel will be found in the appended report of the Veterinary Research Officer.

Mange (Scabies).

Mange in camels was not a serious disease in Darfur, Kassala, or Blue Nile Provinces, but it was widespread amongst Police and

native owned camels in Central Kordofan during the year. It is impossible to keep Police camels free of this disease when they are coming in contact daily with infection either from native-owned camels or at camping grounds infected by the latter. Every effort has been made to keep the disease under control in Police animals by regular dressing and, where possible, by the use of baths.

III. Diseases of Equines.

During the period under report 176 horses, 203 mules, and 33 donkeys died out of a total of about 1,100 horses, 850 mules and 550 donkeys for which forage allowance was drawn. These losses represent approximately 16 per cent. of horses, 24 per cent. of mules, and 6 per cent. of donkeys.

Horse-sickness ("Nigma") was reported to be the cause of death in the cases of 42 horses and 67 mules; epizootic lymphangitis in the cases of 10 horses and 30 mules; and trypanosomiasis in the cases of 7 horses, 9 mules and 3 donkeys.

In Southern Kordofan the diseases known to the natives as "Umluwei" and "Dalag" appear to have caused considerable losses among horses recently, particularly in those of the Homr tribe, and arrangements are being made to investigate these conditions with a view to obtaining all information possible about them.

In the Upper Nile Province intestinal parasites, chiefly *Gastrodiscus acgyptiacus*, are a common cause of losses among mules and donkeys.

Periodic ophthalmia was found to be not uncommon in the horse-breeding areas.

Horse-sickness ("Nigma").

This disease was the cause of a heavy mortality amongst horses and mules in areas where it does not commonly occur. The heaviest losses were registered in the Blue Nile and Red Sea Provinces but several cases occurred in Berber, Kassala, Khartoum, Kordofan and Darfur Provinces. In Port Sudan, Red Sea Province, the disease suddenly appeared at the end of October and by the end of December was responsible for the deaths of 11 horses and 63 mules in the township. The rainfall recorded for the year, up to the end of November, was 24 millimetres in January, 0.5 millimetres in July and 4.8 millimetres in November and the average total rainfall for the previous seventeen years was 127 millimetres. These records were kindly supplied by the Medical Inspector, Port Sudan, who stated at the same time that Port Sudan was practically mosquito-free before and during the outbreak. In this connection it may be mentioned that a portion of the township has recently been placed under irrigation for gardening purposes.

All other outbreaks that came under notice occurred in areas where the rainfall had been greater than normal and were associated with the presence of large numbers of mosquitoes.

The incidence of the disease in the Blue Nile Province was most marked in the Gezira irrigated area owing to the large number of horses kept there and a total mortality of 46 horses was recorded. It was possible to obtain accurate information of the type of animal involved

in some of the areas where the disease occurred and this shows that seventeen out of thirty-one imported animals died as against eleven out of sixty-three Sudan country-bred ponies. As a result of this year's experience many of the stables in the Gezira Area have now been rendered mosquito-proof but unless horses are confined to such stables from sunset until after sunrise during the dangerous season of the year losses from horse-sickness will not be entirely prevented.

Epizootic Lymphangitis.

Epizootic lymphangitis was diagnosed at the Veterinary Laboratory in smears forwarded from 16 horses, 33 mules and 2 donkeys. The majority of these cases occurred in the Upper Nile, Fung and Nuba Mountains Provinces but cases also occurred in Darfur, Blue Nile, Kordofan, Kassala, and Khartoum. A few cases occur every year in mules recently imported from Abyssinia and fresh infection is thus introduced, but as the total number of cases reported this year was fifty-one as compared with sixty-three last year the disease does not appear to be on the increase.

Experimental treatment with biniodide of mercury on a small scale was carried out at the Veterinary Laboratory.

Trypanosomiasis.

Trypanosomiasis of equines was confined to areas where tse-tse flies are known or suspected to exist.

IV. Diseases of Sheep and Goats.

A few mild cases of sheep-pox came under notice in sheep awaiting export to Egypt but no cases of anthrax were reported during the year. In Southern Darfur and Kordofan cases of foot rot occur every year following the rains but no serious losses from any cause have been reported among sheep or goats.

V. Diseases of Dogs.

Three suspected cases of rabies occurred in Kordofan Province and a positive diagnosis was made in a case which occurred at Um Ruaba in April.

One small outbreak involving a dog and a calf occurred in El Fasher, Darfur Province; one outbreak was reported from the Bahr-el-Ghazal Province and the disease was also reported from Nuba Mountains Province.

The measures outlined in last year's report were adopted in all areas where the disease was suspected to exist and the results were apparently satisfactory.

It is estimated that over 2,500 ownerless or stray dogs were destroyed in Darfur, Kordofan, Kassala and Khartoum during the year. It cannot yet be said, however, that the Western Sudan is free of the disease.

A virulent outbreak of distemper was responsible for heavy losses in Khartoum particularly amongst imported dogs and their progeny.

SECTION II.

EXTERNAL AND INTERNAL TRADE.

I. Export and Import Trade.

Cattle and Sheep.

The total numbers of cattle and sheep exported during the period under review were 13,460 cattle and 14,158 sheep, a decrease of 2,424 and 4,915 respectively on the figures for last year. The number of cattle imported shows a decrease of 4,836 on last year's figures. The exports for the last five years were as follows :—

Year		Cattle	Sheep
1923	....	16,382	39,179
1924	....	12,122	25,122
1925	....	19,041	30,870
1926	....	15,884	19,073
1927	....	13,460	14,158

It is estimated that of the total number of cattle exported this year at least 8,000 head were drawn from the Western Sudan.

The prices obtaining on the Egyptian meat market at the end of last year and during the earlier part of this year were exceptionally low and discouraged cattle merchants in the Sudan from holding their usual stocks of cattle and sheep. Prices rose, however, towards the middle of the year and by September the general outlook had improved to such an extent that a return to normal trade conditions in 1928 is anticipated.

Arrangements have been made with the Egyptian Veterinary authorities to provide facilities for forwarding sheep from Shellal to Cairo in small consignments instead of in full train loads and this small concession may have a very helpful effect on the trade.

During the year the cattle and sheep awaiting export were singularly free of disease and no delays, worthy of mention, occurred through outbreaks of disease.

Importations of cattle from French Equatorial Africa, Eritrea and Abyssinia during the past three years, were as follows :—

	1925	1926	1927
French Equatorial Africa	4,138	3,331	1,844
Eritrea	1,229	756	} 1,378
Abyssinia	5,117	3,971	
Totals	10,544	8,058	3,222

Camels.

The improvement noted in connection with our cattle and sheep trade with Egypt towards the end of the year was more than reflected in our camel trade with Upper Egypt. Camel prices rose in the

latter half of the period under review and the number of camels exported from Kassala Province during the year is estimated to have been about 11,250 head. Six thousand camels were sold in El Damer market, Berber Province, and eight hundred and ninety-eight of these were exported to Egypt. It was also reported that 600 camels were purchased in the Blue Nile Province by exporters.

A senior Veterinary Officer was detailed to visit Upper Egypt in December to enquire into the camel trade there and to collect all information bearing thereon.

A considerable number of camels purchased in El Fasher market, Darfur Province, were exported to French Equatorial Africa and an enterprising Omda in Kordofan exported 100 female camels to Kano, Northern Nigeria. In the latter case about twenty per cent. were lost on the way but the balance is stated to have fetched about £E. 19 per head.

Mules.

440 mules were imported from Abyssinia via Gallabat during the year.

Hides and Skins.

The following figures, showing the exports of hides and skins, and their value, for the last four years, have been extracted from the Customs returns :—

Year	Hides Tons	Skins Tons	Total Value
1924	358	426	£E. 62,052
1925	462	601	98,714
1926	428	821	126,431
1927	1,067	932	155,285

The unit value was shown to be £E. 57.7 in the case of hides and £E. 100.8 in the case of skins as compared with £E. 69.4 and £E. 117.9 respectively in 1926.

The quantity of hides exported this year is well above the average and the only years when it was exceeded were 1915 and 1918. The large increases in the quantities of skins exported during the past two years is very satisfactory and the output for 1927 constitutes a new record; of the nine hundred and thirty-two tons exported approximately 800.5 tons were sheep skins and 131.5 tons were goat skins.

The following Omdurman market notes may be of interest :—

At the beginning of January the hide market was weak but a steady improvement set in during the month and, with an increasing demand from abroad, prices of "Fashodas" advanced during the first quarter from £E.44 per ton to £E.52 per ton. Prices continued to rise steadily to £E. 56 at the end of the second quarter, to £E. 68 at the end of the third quarter and finally were as high as £E. 92 to £E. 96 per ton at the close of the year. Other qualities of hides rose in value proportionately during the year.

Prices of sheep skins were good at the beginning of the year but fell considerably in April, May, June and July owing to the small demand from abroad. An improvement was noted in September but was not maintained during the last quarter. The average price paid for “ primes ” during the year was about P.T. 25 per piece.

The market for goat skins improved steadily during the first half of the year but weakened somewhat during July and August. An increased demand from abroad forced prices up in September and the improvement was maintained up to the end of the year. The average price paid for “ heavies ” during the year was P.T. 9 per piece.

From information received from Darfur it would appear that many of the hides which are marketed in El Obeid and Omdurman under the name of “ Fasher flint-dried ” are imported from French Equatorial Africa.

II. INTERNAL TRADE.

Local Livestock Requirements.

With a decreased demand for cattle and sheep for export there was no shortage of suitable animals for local slaughter and prices, especially of cattle, were comparatively low. Normally this would have led to an increased consumption of meat particularly in the towns but the high prices obtaining for grain counteracted this tendency and the figures available show a slight decrease in the numbers of animals slaughtered as compared with the previous year.

It is probable, however, that in the stock-raising areas of the country the high price of grain and the low price of livestock led to an increased consumption of meat in these areas.

The following statement shows the numbers of animals slaughtered for food in ten of the larger towns during the past two years :—

			1926	1927
Cattle	...	....	21,035	21,627
Sheep	....	....	180,509	167,923
Goats	....	....	8,489	9,152
Camels	....	....	1,911	2,284

Valuing these animals on the same basis as was adopted in last year's report, the total values amount to £E. 179,374 in 1927 as compared with £E. 185,842 in 1926.

The numbers of animals purchased locally for Government use during the year are estimated to be 450 horses and 400 riding camels.

Sufficient camel transport was forthcoming, in all the areas requiring same, to meet all requirements.

Hides and Skins.

An indication of the large numbers of hides and skins used locally in the manufacture of native shoes, saddlery, etc. is given by the following figures which were kindly supplied by the Governor,

Khartoum Province, and which represent the average annual requirements of the Omdurman tanneries :—

Camel hides.	1,500 hides.	Sheep skins.	36,600 pieces.
Cattle hides.	9,700 hides.	Goat skins.	12,800 pieces.

Similar statistics supplied by other Provinces indicate that the above numbers of hides and skins represent about half the total numbers used in local tanneries throughout the Sudan.

Samn.

The Customs returns for recent years show that the exports of samn (clarified butter) are balanced roughly by the imports and that the value of this product is about £E. 90 per metric ton. As large quantities of samn are produced by the cattle-owning Arabs there must be a considerable local demand for it.

This samn is of fair quality and fetches about three piastres a rotl but it is doubtful if the present output of the Arabs could be materially increased without causing hardship. Other tribes which do not at present make samn might, however, be induced to do so with profit but, as strict cleanliness must be observed in its preparation, considerable difficulty would be experienced in teaching them to prepare a marketable product. If the average milk yield of a native cow be estimated at the low figure of seventy-five gallons per annum and half this quantity were used in samn-making the annual production per cow would be about seventeen rotls or fifty piastres worth of samn.

SECTION III.

IMPROVEMENT OF LIVESTOCK.

Cattle.

The question of improving the breed of cattle in the Sudan continues to receive close attention and, on the whole, it is considered that the best results will be obtained by breeding from selected local types. It is unfortunate that, by the time it was evident that good grazing was assured in the Western Sudan, it was too late to make the necessary arrangements to hold any cattle shows there but it appears certain that a commencement in this direction will be possible next year. It is proposed, in the first instance, to confine these shows to classes for herd bulls only since, under present conditions, the congregation of large numbers of cows and calves would be liable to cause hardship and might conceivably result in a widespread outbreak of disease.

Selective breeding is practised by the natives of the Sudan mainly with a view to increasing the milk yield of their cows but, generally speaking, the natural grazing and water conditions in the Central Sudan are not such as to hold out much hope of any greater success in this direction than has already been achieved. The selection of herd bulls appears to be carried out on sound lines but a system of intensive in-breeding, presumably adopted originally with a view to fixing certain desirable characters which appeared in the course of out-breeding, has been practised generally for some considerable time and this not only mitigates against the chances of further improvement occurring in the existing type of animal but is liable to result in the appearance of undesirable characters which were latent in the original stock. An endeavour is therefore being made in the Western Sudan to persuade the Arabs to adopt a system of exchanging herd bulls with one another and, if successful, these exchanges will be carried out annually at the cattle shows.

At the same time the possibility of improving the breed of cattle by the introduction of imported blood to areas where grazing and water are plentiful has not escaped attention and five young bulls, bred from native cows by pure-bred imported bulls—four by a Friesian bull and one by a Dairy Shorthorn bull—have recently been sent to the Upper Nile Province. These bulls were rendered immune to rinderpest and pleuro-pneumonia before they were despatched and will be kept under the same conditions as native-owned cattle in the areas to which they are allotted. The result of this small experiment should give an indication as to the suitability or otherwise of the Upper Nile Province for cattle of this type.

In the dairy herd at Khartoum North fifteen heifer calves and fifteen bull calves, bred by the Friesian bull kindly loaned by the American Mission at Gereif, were born during the year and eight heifer calves and two bull calves, bred by the Government's Shorthorn bull, were also obtained. The half-bred stock at the Dairy now consists of five two years old heifers, nine yearling heifers, one yearling bull, eighteen heifer calves and eight bull calves and when compared with native stock the improvement shown is very marked. A small experiment with a view to ascertaining the effects of feeding a ration of bone meal on the milk yield of cows and on the growth and development of young stock is now being carried out at Khartoum North

Horses.

Considerable success has attended the Government scheme to improve the breed of horses in the Western Sudan. Although the scheme was inaugurated in the winter season of 1924-25 it cannot be said to have been fairly launched until the following year and the results so far obtained have surpassed all expectations. The rapid strides which have been made in Darfur Province, where, as a tribute to the personality, tireless energy and boundless enthusiasm of the originator of the movement, the breeding operations are referred to as the "Audas" Scheme, are mainly due to the whole-hearted support afforded by Administrative officers and natives alike. Some nine hundred mares are now under definite breeding control and, at the forthcoming shows, this number will, by careful selection, be increased to one thousand which was the figure aimed at to put the scheme on a sound footing. In order to keep an accurate breeding record a Stud Book has been compiled and each registered sire has been allotted a letter of the alphabet: this letter is tattooed on the upper gums of his progeny and, in this way, the breeding of any particular foal can be told at a glance. As the scheme progresses the standard and quality of registered mares will be gradually raised and the use of country-bred sires with such mares will, as far as possible, be discontinued.

Although the results in Kordofan Province are disappointing when compared with those obtained in Darfur Province, the position there shows a distinct improvement on last year and the natives are now evincing a decided keenness to participate in the horse-breeding scheme. In order to obtain rapid and satisfactory results from a scheme of this nature it is necessary that the ground should first be carefully prepared by means of propaganda and it may have been a lack of such preparation which was responsible for the apathetic attitude of the Messeria tribe towards the Government proposals in the first instance.

The following list shows the distribution of the Government stallions as at 31st December, 1927 :—

Darfur Province.

Allahom, Dign, Talisman, Atbara, Kiolan, Little Tickle, Baccarat, Monarch, Agib, Diamond Jubilee, and No Joke.

Kordofan Province.

Lulu, and Nahud.

Awaiting despatch to Kordofan.

Abu Warda, Farad, Dori, and Talab.

Berber Province.

Greyhound.

Khartoum Province.

Melik, and Hunting Harry.

During the year four Government stallions died of horse-sickness and one old Arab stallion — "Sultan" — was destroyed as old and useless.

The stables at Nyala, Fasher and Abu Zadab have now been rendered mosquito-proof and it is hoped that before the next rainy season suitable stabling will be provided for all imported horses and the risk of losses from this cause will thereby be reduced as far as possible.

SECTION IV.

MISCELLANEOUS.

Grazing and Watering facilities for Livestock.

The adverse conditions which prevailed as a result of poor rainfall throughout the whole of last year in the Northern and Central areas of the country, were again experienced during the first half of this year. In the second half of the year owing to good rains conditions generally improved but the rainfall was rather irregularly distributed, for example, the rainfall recorded in the Provinces of Blue Nile, Kassala, Khartoum and Berber was well above the average whereas in Kordofan and Darfur Provinces it was slightly below normal and in Bahr-el-Ghazal and Mongalla Provinces it was very poor. It may be said, however, that the resulting conditions were generally favourable to livestock. The provision of additional water supplies continues to receive attention from the various Province authorities, particularly in Kassala; from a veterinary point of view such additional supplies in areas where grazing is plentiful will have a very beneficial effect not only on the condition of the stock but on the incidence of disease.

Livestock in relation to cotton production.

The outlook in regard to the livestock industry in the Gezira irrigated area is distinctly bright.

Under present conditions five feddans of dura (*Sorghum vulgare* and five feddans of lubia (*Dolichos lablab*) are grown annually on each holding of thirty feddans and, with the system of watering adopted, these areas are estimated to yield at least fifteen tons of forage in addition to the grain requirements of the tenant. The tenants have now been persuaded to harvest and stack this forage so that, with judicious management, no difficulty should be experienced in maintaining livestock on the holdings throughout the year. The stock owned by the tenants consists of cattle, sheep, goats, donkeys and camels and, as forage is not allowed to be removed from the areas on which it is grown, no difficulty in stocking up the holdings and in thereby improving the soil need be anticipated.

With a view to effecting an improvement in the types of livestock maintained in the area arrangements are being made to carry out breeding experiments at the Gezira Research Farm and, in this connection, two merino rams were recently imported from South Africa. Arrangements are also being made to hold livestock shows in the area as the value of such shows in encouraging natives to improve their stock has been amply demonstrated elsewhere.

The absence of shade for animals during the heat of the day makes the Gezira area a very trying one for animals, particularly in the hotter seasons of the year, but it is hoped that this difficulty may be overcome to some extent by the erection of a simple type of overhead shelter such as is in use at the Gezira Research Farm.

Apart from the losses caused by horse-sickness the general health

of the animals in the area was good throughout the year and the losses reported amongst work oxen were less than in any previous year. Outbreaks of rinderpest and pleuro-pneumonia occurred outside the area but only one small outbreak of rinderpest, attended by few deaths, occurred within the area. All the work oxen and some of the tenants' cattle were again vaccinated against contagious bovine pleuro-pneumonia in order to reduce the risk of losses from this disease to a minimum.

Animal Management.

With a view to assisting junior Political Officers to acquire some knowledge of the principles of animal management one hundred copies of the Military Manual on this subject, prepared in the Veterinary Department of the War Office, London, were obtained for distribution. The need for such a manual is evidenced by the fact that it was found necessary to order fifty more copies to supply the demand.

Buildings.

The Veterinary Hospital at Wad Medani was completed during the year and brought into use. Improvements continue to be carried out to the Veterinary Hospital at Kassala and arrangements are being made to provide sick lines at Gedaref.

General.

During the last two years there has been a considerable expansion of Veterinary activities. For the past twelve months the strength of Veterinary Inspectors has been two under establishment and, in the circumstances, the progress that has been made reflects great credit on the whole Veterinary staff.

Every endeavour continues to be made to keep in close touch with the work of other veterinary organizations in Africa and elsewhere in order that mutual benefit may accrue from any important discoveries recorded.

This opportunity is taken to acknowledge with thanks the assistance so freely rendered to the Department during the year by the Director of the Wellcome Tropical Research Laboratories and his staff.

W. KENNEDY,

Director, Veterinary Department, S. G.

ANNUAL REPORT
of the
VETERINARY RESEARCH OFFICER,
SUDAN GOVERNMENT.
1927.

STAFF.

Veterinary Research Officer.

This post was held by Major R. H. Knowles, R.A.V.C. until March 31st, on which date he reverted to the British Army. With effect from this date the post has been held by myself.

Assistant Veterinary Research Officer.

Held by myself until March 31st, on which date I was appointed Veterinary Research Officer; since this date the post has been vacant. Mr. A. L. Mullen, Veterinary Inspector, has been attached to the Laboratory from May 28th and has acted in the post.

Laboratory Assistant.

Mr. P. A. C. Kenny has held the post throughout the year.

A. ROUTINE WORK.

I. Examination of Specimens.

During the year a total of 736 specimens has been received in the laboratory, of which 731 have been examined and reports made, while the remaining five were entomological specimens and were passed on to the Government Entomologist. The following is a detailed list arranged under heads of animal species.

Camels.

Trypanosoma soudanense	...	...	...	...	...	53
Trypanosoma congolense	...	...	...	...	...	2
Filariasis	...	...	...	...	...	2
Streptococcic septicaemia	...	...	...	...	...	1
Tuberculosis (generalised)	...	...	...	...	...	1
Negative	...	...	...	...	...	166
						— 225

Horses.

Piroplasma caballi	...	...	...	...	...	19
Nuttallia equi	...	...	...	...	...	3
Piroplasma and Nuttallia	...	...	...	...	...	1
Trypanosoma congolense	...	...	...	...	...	5
Trypanosoma brucei	...	...	...	...	...	1
Epizootic lymphangitis	...	...	...	...	...	16
Pyogenic infections	...	...	...	...	...	24
Filariasis	...	...	...	...	...	2
Negative	...	...	...	...	...	117
						— 188

Mules

Piroplasma caballi ...	...	...	...	...	...	3
Trypanosoma brucei ...	...	...	...	...	...	1
Epizootic lymphangitis ...	...	...	...	...	...	33
Pyogenic infections ...	...	...	...	...	...	30
Filariasis ...	...	...	...	...	...	2
Habronemic granuloma ...	...	...	...	...	...	1
Negative ...	...	...	...	...	...	74
						— 144

Donkeys

Piroplasma caballi ...	...	...	...	...	...	1
Epizootic lymphangitis ...	...	...	...	...	...	2
Pyogenic infections ...	...	...	...	...	...	3
Tuberculosis (?) ...	...	...	...	...	...	1
Negative ...	...	...	...	...	...	10
						— 17

Cattle

Theileria (? mutans) ...	...	...	...	...	...	4
Piroplasma bigeminum ...	...	...	...	...	...	1
Mixed Theileria and Piroplasma ...	...	...	...	...	...	1
Trypanosoma congolense ...	...	...	...	...	...	2
Trypanosoma vivax ...	...	...	...	...	...	1
Pyogenic infections ...	...	...	...	...	...	1
Negative ...	...	...	...	...	...	61
						— 72

Sheep

Theileria (? ovis) ...	...	...	...	...	...	1
Negative ...	...	...	...	...	...	2
						— 3

Pigs

Trypanosoma congolense ...	...	...	...	...	...	1
Trypanosoma brucei ...	...	...	...	...	...	1
Negative ...	...	...	...	...	...	1
						— 3

Dogs

Piroplasma canis ...	...	...	...	...	...	1
Rabies ...	...	...	...	...	...	1
Sarcoma ...	...	...	...	...	...	1
Negative ...	...	...	...	...	...	24
						— 27

Fowls

Spirochaeta gallinarum ...	...	...	...	...	...	15
Negative ...	...	...	...	...	...	30
						— 45

Miscellaneous negative specimens.

Goats 5, Rufifrons Gazelle 1, Parrot 1 ...	...	...	...	...	...	7
Entomological Specimens ...	...	...	...	...	...	5

TOTAL ... 736

II. Notes on Specimens Examined.

(i) *Trypanosomiasis*.

With the exception of camel trypanosomiasis, which will receive special mention, the number of positive specimens examined has been small, but of considerable interest.

As has been noticed in previous years most of the cases have been diagnosed in material from the Koalib Hills, Nuba Mountains Province; the species of trypanosome and of host being most conveniently shown in the following table :

Species.					<i>Tr. congolense.</i>	<i>Tr. brucei.</i>
Horse	....	....	....	....	4	1
Pig	....	....	....	....	1	1
Camel	....	....	....	....	2	—

Of these diagnoses the most interesting is that of *Tryp. congolense* in camels, as it seems that this trypanosome has rarely, if ever, been found occurring naturally in camels. The outbreak occurred in a party of 75 camels which were working in approximately equal halves on the East and West of the Koalib Hills, and was first diagnosed in fresh blood preparations by the Director of the Veterinary Department whilst on tour in the Nuba Mountains Province in February. Dry films examined at this Laboratory showed a heavy infection of *Tryp. congolense* type. At the time of Mr. Kennedy's tour 12 camels had died, probably all from trypanosomiasis, all East of the hills. Later the Eastern party was withdrawn and the camels mixed with the Western party. Ultimately 36 camels died, constituting most probably the whole of the original Eastern party. Further mention will be made of *Tryp. congolense* infection in camels when reporting on research.

The remaining cases of trypanosomiasis are of little interest. *Tryp. congolense* (cow) and *Tryp. brucei* (mule) were diagnosed at Malakal, and *Tryp. congolense* and *Tryp. vivax*, both in cattle at Kosti, in which district there were appreciable losses.

(ii) *Epizootic lymphangitis*.

Of the 51 cases diagnosed 30 were in specimens from the Fung (18) and Blue Nile (12) provinces, which is in accordance with the observations of previous years. One is not, however, justified in assuming that the disease is more serious in these provinces than elsewhere; for example, of the pus smears received from these two provinces approximately two-thirds were negative whereas of those received from Kordofan and Darfur there were exactly equal numbers of positive and negative diagnoses. Smears were also sent in smaller numbers and positive diagnoses made from Kassala, Khartoum, Nuba Mountains, White Nile and Upper Nile Provinces.

The most interesting case of the disease was in a horse (Khartoum Province) in which the infection was confined to the *membrana nictitans* of one eye. Rare case of similar infection have been reported from other countries but it is thought advisable to draw attention to this case as a reminder that such cases do occur, and it is possible that more of them may be found in the Sudan.

(iii) *Pyogenic infections.*

It will be noticed that no diagnoses of “ ulcerative lymphangitis ” have been made, all smears containing diphtheroid bacteria having been classed as pyogenic infections. In reporting on these specimens to the senders a statement of the proportion of diphtheroid organisms has been made, but in view of our present meagre knowledge of diphtheroid bacteria generally and the fact that they are commonly found in this country in greatly varied conditions in several species of animals, it has not been considered justifiable to use the term “ ulcerative lymphangitis ” in diagnosis.

(iv) *Tuberculosis in a Camel.*

The subject was a camel that died suddenly in Khartoum. A post-mortem examination showed it to be intensely infected with generalised tuberculosis. The rapidly fatal infection of laboratory animals, and the failure to cultivate the organism although present in large numbers show that the infection was of the bovine type. The case is interesting in that bovine tuberculosis is extremely rare in the Sudan and no case in a camel has hitherto been noticed in this country.

III. Control of camel trypanosomiasis (*Tr. soudanense*).

As the result of Major Knowles' researches from 1924 to the time of his departure it has been decided that the efficacy of the formol-gel test as a method of diagnosis and of Naganol as a curative agent have been sufficiently established to warrant their general use in the field. The rationale of the system is as follows :—

(a) The formol-gel test is considered to be an accurate method of diagnosis in over 90 per cent. of cases; a few non-infected camels react, and still fewer infected camels fail to react provided a sufficient interval be allowed to elapse between the probable date of infection and the performing of the test. It is thought that about two months is a sufficient interval, at any rate in most cases.

(b) The common season for camels to become infected is during the rains, in camel areas from June to September, so that by applying the formol-gel test in November or later very few infected camels should be missed. The test should, however, always be supplemented by microscopic examination of the blood.

(c) Naganol in 10 gramme doses intravenously is a primary cure in probably 100 per cent. of cases but as a prophylactic it is of doubtful value.

(d) Following on the above, the treatment is to submit all camels to the formol-gel test and to give 10 grammes of Naganol to the positive reactors only. A reaction is considered to be positive when two drops of strong (40 per cent.) formalin mixed with 1 c.c. of serum induces gelation in 24 hours at ordinary shade temperature, which in buildings is fairly steady in the winter at from 80 degrees to 90 degrees F.

The necessary apparatus and the Naganol are being supplied to Veterinary Inspectors by this Laboratory, the latter being dispensed in single 10 gramme doses. During the year 426 doses have been issued.

With a view to obtaining as much further information as possible arrangements have been made with all field workers to send to the Laboratory particulars of each camel tested and treated. It is thus hoped ultimately to obtain further evidence of the efficacy of the system on an extended scale, with particular regard to the question of relapses or re-infections.

IV. Control of Contagious Bovine Pleuro-Pneumonia.

The issue of a single dose living culture vaccine has been continued. No difficulty has been experienced in meeting demands from the field although these have been more than twice as large as last year, 9,410 doses having been issued as against 4,250 doses in the period covered by last year's report, viz: 1st October, 1925 to 31st December, 1926.

Special requests have been made to field officers to notify the laboratory of any accidents following vaccination but no mishap has been reported. All batches of vaccine sent out have been grown in ordinary serum peptone broth and have ranged from 18 to 70 (weekly) subcultures in age.

Vaccine preparation has been chiefly under the personal control of Mr. Mullen.

B. RESEARCH.

The amount of research work performed during the year has been limited as I have been absent from the Laboratory for five months since taking charge—one month touring in the Upper Nile Province and four months on leave.

I. Trypanosomiasis.

As in earlier years more attention has been paid to this disease in camels than in other animals, largely because more material has been available. The treatment of camels in the field with Naganol having been in the main handed over to the field staff, other aspects of the disease have received limited attention on account of the expense involved in purchasing and keeping experimental animals. The experiments that have been performed are described under various heads as follows :—

(i) Duration of immunity in cured Camels. (T. soudanense).

Before describing this year's experiments it will be advisable to analyse more closely the observations recorded in earlier years since one is unable entirely to agree with the conclusions drawn therefrom.

Observations on three camels were recorded, the details being as follows :—

Case No. 1 (Camel 1052, a natural case).

Treated at the end of January, 1924, with 18 grammes of Naganol in three doses of 6 grammes at two-day intervals and completely cured. In November 1924, nine and a half months after cure, it was re-tested by inoculation with infected blood and become infected and, moreover, developed a positive reaction to the formol-gel test. Two control camels developed a more acute attack of the disease. The camel is recorded as having a "relative immunity" of nine and a half months' duration.

Case No. 2 (Camel 1, a natural case).

Treated in December, 1924, with 6 grammes of Naganol. Trypanosomes disappeared but reappeared 11 weeks later. Camel treated again in March, 1925, with 10 grammes of Naganol and was completely cured. Infective blood injected in January, 1926 (nine and half months) and again in February, 1926, and again in November, 1926. After none of these injections did trypanosomes appear, the reaction to the formol-gel test remained negative and inoculated small animals remained healthy.

Case No. 3 (Camel 1630, a natural case).

Treated on 19-11-25 with 10 grammes of Naganol and completely cured. Tested on 2-1-26 (6 weeks later) and trypanosomes reappeared in the blood, but only for a few days. A second injection of infective blood two months later was not followed by reinfection. Animal tests were also negative.

To discuss these cases, in the first one the camel had 18 grammes of Naganol and at the end of eleven months behaved towards reinfection in a similar manner to many "clean" camels—it developed a chronic infection and its formol-gel reaction became positive. That two control camels developed a more acute infection is of little interest; when infecting a batch of several camels for experimental purposes all degrees of acuteness are seen, some cases being acute and progressive, some acute and reverting to chronic and some chronic throughout. Thus instead of claiming a "relative immunity" it is better to suspend judgment and be prepared to doubt whether there was any immunity at all. In the second case the camel was certainly immune when tested nine and a half months after the *last* treatment, but as is pointed out in the original report one must be prepared to regard this camel not as merely treated but "reinforced." In the third case, where the camel was treated on the lines provisionally accepted as the routine treatment, *i.e.*, cured by the first injection of 10 grammes of Naganol, the immunity, which was definite, was only proved after an interval of six weeks. It has been claimed by YAKIMOV * and his collaborators working with the same type of trypanosome in camels in the Ural region that Naganol alone may be a prophylactic for a period of three months, when the immunity is tested by exposure and not by reinfection.

* YAKIMOV W. L. *et. al. Russian Jl. Trop. Med.* 1927, Vol. 5, p. 43, Abst. in *Trop. Vet. Bull.* 1927, Vol. 15, p. 97.

Opportunity has since arisen in Khartoum to test the immunity of three cured camels, two cured with Naganol alone and one with Naganol combined with Sodium Antimony Tartrate. The details of these three are as follows :—

Camel No.	Treatment	Date.	Date of Retest	Result.
L. 8	10 gm. Naganol.	28-11-26	31-5-27	Remained free, animal inoculations negative.
L. 6	3 gm. Naganol 2 gm. Ant. Sod. Tart.	1-11-26	31-5-27	As L.8.
L.4	10 gm. Naganol.	26-1-24	31-5-27	Tryps. reappeared 23rd day. Progressive acute infection. Died 29-10-27. <i>Formol-gel reaction negative until death.</i>

From the above statement there is no doubt that Nos. L.8 and L.6 were immune after a period of approximately six and seven months respectively, while No. L.4 after a period of over three years was not.

In view of the uncertainty that still exists as to the duration of immunity in cured camels, and with special regard for the extended scale on which infected camels are at present being treated with Naganol, an experiment has been started based on the periodical re-testing of small lots of camels from a larger lot that have been deliberately infected and then cured with a single dose of 10 grammes of Naganol. The camels for this experiment have been kindly lent by the Medical Officer of Health for Khartoum (Dr. J.C.N. HARRIS) and it is intended that throughout the observations they shall continue to do their ordinary work, thus simulating as far as possible natural conditions. Also, by the kindly co-operation of Dr. Harris, the experiment can be carried out with practically no expense.

(ii) *Diagnosis (T. soudanense).*

The formol-gel test is the best diagnostic measure at present available for detecting trypanosomiasis in camels. Of the camels tested by Major Knowles during the last two or three years it has been reliable in over ninety per cent. of cases. One had hoped that this proportion might hold good, since the reliability was estimated from the testing of 125 infected camels out of which only two failed to react. Recently, however, reports have been received from officers on trypanosome work in the field of several camels found to be infected by microscopic examination of the blood but not reacting to the test. It is difficult to follow up field cases, but in the laboratory two cases have been observed during the last few months of camels which actually died of trypanosomiasis before developing a positive reaction. Records from the field continue to show that as a method of diagnosis this test is far superior to microscopic examination alone, and its use must certainly be continued. The failures, although still small in numbers—too small to express in terms of percentage — are never-

theless more numerous than was anticipated, and while still continuing to use the formol-gel test as a diagnostic, attempts are being made to develop other tests. This work, which entails the use of many compounds, is being done largely by Mr. Kenny.

(iii) *Treatment with Naganol and Potassium Antimonyl Tartrate (T. soudanense).*

This treatment was tried by Major Knowles as being a combination of the two best available therapeutic agents. A second object was that by replacing a certain amount of Naganol by the much cheaper Tartar Emetic a more economical form of treatment would be available. Very little work has been done on these lines since his departure but recent returns from Kassala show that none of the twelve camels treated there early in 1926 have been reinfected.

(iv) *Treatment with Naganol and Sodium Antimonyl Tartrate. (T. soudanense).*

A great objection to the intravenous injection of ordinary Tartar Emetic (the potassium salt) is the very severe reaction that it produces in camels showing trypanosomes in the blood stream at the time of treatment. It is admitted that camels rarely die in consequence; but a few do, and the loss of very few animals will counteract a considerable number of small savings in the cost of Naganol. It has been stated that the sodium salt produces less severe reactions and its use has been tried up to date on three camels. The details of these are as follows:—

Case 1. Camel No. L.6, a natural case, formol-gel positive, trypanosomes absent at the time of test but appeared intermittently later.

1-11-26. Trypanosomes *absent* from blood. Injected intravenously with Naganol 3 grammes and Sodium Emetic 2 grammes. No symptoms followed the injection. Trypanosomes permanently disappeared from the blood, the camel improved in condition and the formol-gel reaction was negative at the end of 50 days.

31-5-27. Attempted reinfection with infected blood. Trypanosomes never appeared in the blood, formol-gel reaction remained negative for five months. Laboratory animals inoculated after five months remained healthy.

Case II. Camel No. L.7, a natural case, formol-gel positive, trypanosomes present at time of test (27-10-26) and intermittently later.

1-11-26. Trypanosomes *present* in blood in fair numbers. Injected intravenously with Naganol 3 grammes and Sodium Emetic 2 grammes. Injection was followed in less than a minute by violent symptoms of shock—urination, defaecation, vomiting, trembling, etc. Trypanosomes disappeared within an hour but the camel never recovered clinically and died on the 12th day. Post-mortem examination showed that the camel died as the result of septic double pneumonia and further that a few old encapsulated and partly calcified lesions and many recent foci of infection were present. It seems probable that the shock following the injection had broken down some old lesions and induced extensive re-infection from them.

Case III. Camel No. 652 C.C., a natural case, formol-gel positive, trypanosomes continuously in the blood from 31-5-27 to 2-6-27.

2-6-27. Trypanosomes *present* in blood. Injected intavenously with Naganol 4 grammes and Sodium Emetic 2 grammes. Very severe symptoms of shock developed immediately after injection and at the end of 15 minutes it was doubtful whether the camel was alive or dead; at the end of 30 minutes it was able to sit up and ultimately recovered. Two months later after negative animal inoculations it was considered cured and was returned to its unit whence no report of relapse has been received.

From the three foregoing cases it can be judged that a combination of Sodium Antimonyl Tartrate and Naganol is probably as effective a treatment as the latter drug combined with the Potassium salt, and may serve to reduce the dose of the more expensive Naganol. Unfortunately, however, the degree of shock in animals showing blood stream infections may be as severe following injection of the Sodium as of the Potassium salt. It is probable that one may ultimately institute a scheme of trypanosome control in which the camels found to be infected by direct microscopic examination of the blood will be treated with Naganol alone, while those diagnosed by indirect methods will receive a combination of one of the Antimony salts with Naganol.

(v) *Other species of trypanosomes in camels.*

(a) *Tryp. congolense.*

Reference has already been made in the section on Routine to the occurrence of an outbreak of *Tryp. congolense* among camels in the Nuba Mountains. As the disease had appeared to run a very acute course under field conditons it was decided to study it more closely in the laboratory. A strain of the trypanosome in white rats had been sent to the Wellcome Tropical Research Laboratories, and by their courtesy I was provided with virus, thus saving the trouble that would have been entailed in sending specially for an infected camel. It must be admitted that the trypanosome strain had been passaged a few times in rats before these experiments were performed and may possibly have become modified in some characters. Observation of two camels infected in this laboratory from white rats seemed to indicate, however, that from the general clinical point of view no appreciable alteration in virulence had occurred. Two normal camels were infected with a view to treating one of them and keeping the other as a control. The detailed records of the two camels are as follows :—

Camel 74. (Control.)

8-5-27	given $\frac{1}{4}$ c.c. blood from white rat.
27-5-27	tryps. appeared (19th day).
4-6-27	off feed, first clinical symptom (27th day).
6-6-27	weakness of hindquarters when walked about.
7-6-27	died suddenly (30th day).

Blood infection with trypanosomes was continuous and intense.

Camel 84.

- 8-5-27 given $\frac{1}{4}$ c.c. blood from white rat.
21-5-27 tryps. appeared (13th day).
23-5-27 off feed, first clinical symptom (15th day).
24-5-27 collapsed and became comatose, tryps. swarming.
10 grammes Naganol intravenously.
25-5-27 trypanosomes present but fewer in number.
26-5-27 trypanosomes absent.
The camel became quite normal from this point.
3-6-27 trypanosomes reappeared (10 days after treatment).
4-6-27 off feed and movements incoordinated.
20 gm. Naganol intravenously.
5-6-27 trypanosomes absent, camel quite normal.
13-6-27 trypanosomes reappeared (10 days after last treatment).
14-6-27 10 gm. Naganol and 2 gm. Sodium Emetic intravenously.
15-6-27 trypanosomes absent, camel quite normal.

From this point onwards the camel seemed to be quite normal both as regards temperature and outward clinical signs. No more trypanosomes were seen until the camel died on 9-7-27 of acute enteritis (24 days after the last treatment).

It is not possible from the two foregoing cases to draw any general conclusion, but in conjunction with evidence from the field it may be said that *Tryp. congolense* infection in camels runs a very acute course, being remarkable not so much perhaps for its short incubation period as for the extreme rapidity with which collapse and death follow the appearance of the trypanosomes in the blood stream. Further, it is more difficult to cure than *Tryp. soudanense* infection. It is unfortunate that camel No. 84 died of intercurrent disease so soon and it is impossible to be certain that it was permanently cured, but from the short period required for relapses after the earlier treatments with Naganol alone and the length of time the camel remained free from blood infection after treatment with a combination of Naganol and Sodium Emetic it seems at least probable. It is also highly probable that the cumulative action of a total of 40 grammes of Naganol played some part.

If it is ever necessary in future for camels to work in an area known to be infected with *Tryp. congolense* this infection will require further study.

(b) *Tryp. brucei (rhodesiense)*.

In last year's report of this laboratory a case was recorded of one camel that was infected by Major Knowles with *Tryp. brucei (pccaudi)* from a mule, and was cured with a single dose of 10 grammes of Naganol. With a view to obtaining further information on the general behaviour of camels towards trypanosomes of the Sudan, and quite apart from the close relationship of *Tryp. brucei (pccaudi)* of animals and *Tryp. brucei (rhodesiense)* in man, a camel was infected with a Sudan strain of the latter. This strain was obtained from the Government Bacteriologist, Wellcome Tropical Research Laboratories. The details of the case are as follows :—

- 8-5-27 given 1. c.c. infected blood from white rat.
15-5-27 trypts. appeared in blood (7 days).
25-5-27 trypts. have been continuously present in the blood in moderate numbers, temperature continuously about 3 degrees F. above normal.
26-5-27 10 gm. Naganol intravenously (18th day).
27-5-27 trypts. scanty in blood.
28-5-27 blood examination negative.
3-10-27 blood still negative, formol-gel negative, two guinea-pigs inoculated remained healthy.

There is little discussion necessary on this case. The camel behaved in exactly the same manner as the earlier one did in regard to the mule strain of *T. brucei*. Further, the camel was equally easily cured with a single dose of 10 grammes of Naganol.

II. Contagious Bovine Pleuro-Pneumonia.

The chief work in connection with this disease has been designed to ascertain more fully the antigenic value of living culture vaccine. By the end of last year it had been shown that a culture of the virus in serumised "plain" broth was as good as a culture in "Martin's" broth and that at a test ten weeks after vaccination bulls that had been vaccinated with culture of the 13th, 15th, 16th, and 66th (weekly) generations all showed a strong immunity when tested with virulent lymph. As a result of this test one has felt justified in issuing culture vaccine for field use up to an age of at least 60 generations.

At this point, however, no information was available on the following points, which seemed to be of most importance.

- (i) The time taken for immunity to develop.
- (ii) Whether immunity would develop more quickly with culture viruses kept for shorter or longer periods in artificial culture.
- (iii) The duration of immunity.

Fairly definite information has now been obtained on all these points, and conclusive evidence in the case of the first two. The details of the experiments carried out were as follows :—

(i) *Time required for immunity to develop.*

Before describing this year's work it is as well to recall an experiment to which brief reference was made in last year's report (p. 32). In this test the cattle were tested a fortnight after vaccination; some developed typical pleuro-pneumonia reactions and some atypical swellings in which bacteria were discovered, while others seemed to be immune. The indefinite results were ascribed to (a) the possibility of having tested too soon after vaccination, and (b) the possibility of having used a test lymph (coming from a natural case) in which there was some bacterial infection, although this had not been detected either macroscopically or microscopically. In view of the more recent work it seems that both these factors played a part and from that date all test virus has been from shoulder tumours after a few passages. The details of the above test need not be given here, but will be set out later in a full publication.

The first experiment this year was done with a view to finding the time required for immunity to develop with the actual vaccine that was being issued during the season for use in the field, *i.e.*, a culture virus of something less than 60 generations; actually a culture of the 47th generation was used. Ten bulls were injected subcutaneously each with 2 c.c. of living culture of a week's incubation with the intention of testing their immunity after intervals of two, four, six and eight weeks, or as near these times as the condition of virus-passage cattle would permit of obtaining lymph for testing purposes. The programme was carried out as planned except that the eighth week test had to be performed at the ninth week. In all cases the immunity was tested by the subcutaneous injection of 1. c.c. of virulent lymph.

TABLE I.

Time required for immunity to develop in cattle inoculated with
“stock” vaccine (culture of 47th generation).

All cattle vaccinated on 14-11-26.

Date of test.	Period since vaccination.	Bull No.	Result.
28-11-26	14 days	101	Progressive local swelling and fever, slaughtered in extremis on 15th day.
	14 days	102	Progressive local swelling and fever, slaughtered in extremis on 28th day.
	Control	110	Progressive local swelling and fever, slaughtered moribund on 28th day.
13-12-26	29 days	103	Moderate local swelling during second week and fever second and third weeks. Recovered.
	29 days	104	Progressive local swelling and fever, slaughtered moribund on 20th day.
	Control	112	Progressive local swelling and poly-arthritis, continuous fever, slaughtered moribund 21st day.
	Control	96	Diffuse local pain but no swelling, no rise in temperature. Apparently a naturally immune bull.
26-12-26	42 days	105	Moderate local swelling during second week, very little fever. Recovered.
	42 days	106	Progressive local swelling and fever. Slaughtered moribund on 21st day.
	Control	114	Progressive local swelling and fever. Slaughtered moribund on 24th day.
	Control	115	As above, slaughtered moribund on 20th day.
16-1-27	63 days	107	Swelling never more than 1 in. by 1 in. No fever. Recovered.
	63 days.	108	Exactly as above. Recovered.
	Control	113	Progressive local swelling and fever, slaughtered moribund on 17th day.
	Control	122	Exactly as above. Slaughtered on 26th day.

From this tabular record it is seen that the vaccine employed produced no immunity in a fortnight; at four and six weeks by the survival of one of the two test animals after a moderate reaction one sees (a) that the bulls were susceptible and (b) that the immunity was in process of development; at nine weeks the immunity was solid.

At this point in the investigation it is possible to give assurance to the field worker that the vaccine supplied throughout the season has been safe, and efficient, and should produce a solid immunity in about two months.

(ii) *The influence of age in subculture on the time required for immunity to develop.*

Having found that the vaccine culture of 47 generations produced a solid immunity in about two months another experiment was designed with the object of finding whether the length of time in subculture influenced the prophylactic power of the virus as regards the length of time required for immunity to develop. It was decided to test cultures of three ages (a) of very few subcultures, (b) of several weeks in subculture, and (c) very old; information having already been obtained on cultures of moderate age by earlier experiments. Eight bulls were each given cultures of the three ages with the object of testing two of each batch at two to three week intervals. Of the eight bulls receiving very young culture four died as a result of the injection and later in the experiment some of the others died—probably as a result of eating unripe dura—although they showed no reaction whatever to the vaccine. The survivors were tested according to the original programme; a brief tabular summary of the results is shown in Table II.

TABLE II.

Test of vaccinated bulls to ascertain the relation between age of vaccine in subculture and rate of development of immunity.

Period since vaccination	Generation of culture	Bull No.	Result.
3 weeks	2	128	No thermal or local reaction, both lived.
	2	133	
	17	139	Mild fever and moderate local swelling during 2nd and 3rd weeks, lived.
	17	140	No thermal or local reaction, lived.
	115	147	Moderate fever and moderate local swelling during 2nd and 3rd weeks, lived.
	115	154	Progressive local swelling and fever, died on 26th day.
	Control	160	Progressive local swelling and fever, destroyed moribund on 19th day.
	Control	163	Exactly as No. 160, died on 23rd day.
6 weeks	2	135	No thermal or local reaction, both lived.
	2	136	
	17	142	No thermal or local reaction, both lived.
	17	143	
	115	157	Moderate fever during 2nd and 3rd weeks, moderate local swelling lasting over a month, lived.
	115	159	Moderate fever and local swelling during 2nd week only, lived.
	Control	165	Progressive local swelling and fever, died on 21st day.
	Control	166	No reaction, lived. (A naturally immune bull).
9 weeks	17	141	No thermal or local reaction, all lived.
	17	144	
	17	146	
	115	162	Progressive local swelling and fever died on 28th day.
	Control	168	Progressive local swelling and fever destroyed moribund 16th day.
	Control	170	Exactly as No. 168, died on 17th day.

The records summarised in this table need not be discussed at length in this report. It is easily seen, however, that the very young culture of the second generation not only produced immunity very rapidly but, having killed half the animals vaccinated, it would be too dangerous for field work. The culture of the 17th generation was almost equally effective and was perfectly safe. The old culture of the 115th generation may be assessed as almost useless.

These results are of the greatest importance, in that on them must be based the technique of preparing vaccines for use in the field. These vaccines must primarily be safe, and within the limits of safety one requires a vaccine that will produce immunity in the shortest possible time. It is shown beyond doubt in these two experiments that the less time a virus has been kept in artificial culture the more rapidly it produces a solid immunity, while if kept too long in artificial culture it becomes almost if not quite useless. For field work therefore, one must supply the youngest safe generation of culture virus, but, as slightly older cultures are only a little slower in producing immunity there is no very urgent need for making original cultures at short intervals.

(iii) *Duration of immunity.*

Only one small controlled experiment has been performed at present consisting of the testing of three cows that had been vaccinated in 1925 and 1926. The history of the three cows was as follows :—

Cow 150.

June 1925, half c.c. culture virus in Martin's broth (tail).
October 1925, 1 c.c. culture virus in Martin's broth (neck)

Cow 151.

Exactly as above.

Cow 152.

As above in 1925. November 1926, 2 c.c. culture virus in plain serum broth.

All three were tested on 16-5-27 by the subcutaneous injection of 1 c.c. of virulent tumour lymph. None of them developed any fever but all three developed small swellings during the second week which disappeared during the third week. Two control bulls, Nos. 175 and 176 developed acute progressive reactions terminating fatally on the 23rd and 19th days respectively. The longest period between vaccinating and testing—Nos. 150 and 151—was one year and seven months, after which interval the cattle still had a strong immunity. Reference to earlier records show that the generation of culture virus used in 1925 would probably be about the 30th in June and the 50th in November; no actual record was kept but it is known that the vaccine strain of virus then in use had been isolated at the end of October 1924 and transplanted weekly.

From a single experiment on this small scale it is not possible to draw any definite conclusions, but it seems at least likely that immunity in effectively vaccinated animals is still fairly strong at the end of two years. A definite experiment on a large scale has now been started with a view to obtaining more complete evidence on the duration of immunity following vaccination.

(iv) *Studies on the virus in artificial culture.*

Following my original studies on these lines, which were responsible in the first place for discarding "Martin's" broth as a culture medium, it has been observed that the pleuro-pneumonia virus is not nearly so delicate an organism as has been generally supposed. In culture media made with a basis of Martin's broth it has certainly shown itself to have a slender hold on life, and in surface cultures on serum agar prepared from Martin's broth it was sometimes impossible to obtain growth—in fact attempts to get surface cultures on this medium from original lymph have been uniformly unsuccessful. On serum agar prepared with commercial peptones primary cultures have been easily obtained, and it is practicable to isolate a pure culture from contaminated lymph by the ordinary bacteriological process of plating out.

Attention has also been given to the reaction of the medium necessary for good growth. It seems to be generally assumed that P.H.8.0. is the optimum, but this reaction is notoriously difficult to maintain in culture media. A few preliminary experiments have shown that there is no appreciable difference either in the luxuriance of growth or the viability of cultures in our stock medium between reactions considerably on the acid side of neutrality and reactions of over P.H.8.0. The reactions of batches of media have been checked both colorimetrically and electrically. In any case it is difficult to understand why a reaction of P.H.8.0. should be the optimum; several checks of the reaction of both lung and tumour lymph have constantly shown the reactions to lie between P.H.7.2 and P.H.7.4, *i.e.*, the reaction of normal body fluids.

A great deal more research is necessary on the cultural characters of the pleuro-pneumonia virus, especially with a view to increasing its viability for the purpose of carrying out vaccination at long distances from Khartoum. The preliminary studies have in any case been encouraging in that they have at least shown that the virus is not so delicate as was formerly believed.

III. Epizootic lymphangitis.

Preliminary work only has been instituted with a view to finding some method of curing this disease. Following the lines indicated by NAINSOUTA * in Senegal, two cases—a horse and a mule—which came to notice in Khartoum were treated with intravenous injections of Mercuric Iodide. It was found that using the small doses suggested by Nainsouta the lesions became worse, but using larger doses both cases were cured. Owing to the necessity of giving several intravenous

* NAINSOUTA R. Action spécifique du biiodure de mercure contre la Lymphangite Epizootique.—*Recueil de Med. Vet.* 1926, Vol. 102, p. 534.

injections it cannot be claimed that the treatment is suitable for general application in the field. It is of use, however, in that individual animals of considerable value can be treated in hospital with some hope of success. It is intended to exploit treatment with Mercuric Iodide as exhaustively as possible in the near future.

IV. Equine piroplasmosis (Biliary fever).

As can be seen from the record of specimens set out in the section on Routine, it appears that *Piroplasma caballi* is encountered much more commonly than *Nuttallia equi*. In spite of its widespread nature there is little definite information on the treatment of piroplasmosis, especially the form due to *P. caballi*. Regarding infection with *Nuttallia*, recent work in South Africa has shown that no drugs tried were of any appreciable use.

The commonest drug employed by British veterinarians for the treatment of both forms has been Quinine Hydrobromide, which was generally adopted as the result of observations published by WILLIAMS * in India as long ago as 1914. Although the disease is described as Nuttalliosis references to "large pear-shaped parasites" make it certain that some of the cases at any rate were due *P. caballi*. It is not intended to discuss the literature any further at this point; both forms of piroplasmosis occur in the Sudan and several cases have been treated with Quinine Hydrobromide.

It is hoped to publish full case reports later, but it is worthy of note that at the present stage one has noticed that in infection with *P. caballi* the injection of Quinine Hydrobromide has no noticeable effect on the parasites, and these remain in the blood stream for some weeks after the horse is "cured" in the clinical sense. From the point of view of the clinician, however, this drug has been almost invariably successful in reducing fever and generally ameliorating the patient's condition.

No cases of pure Nuttalliosis have been available for treatment, but in mixed infection with both types of piroplasm recognisable the treatment has been far less efficacious. It is worthy of mention in this connection that it is very easy to mistake a mixed infection for a pure *P. caballi* infection: in some of the cases daily examinations for many days were carried out before being able to indentify *N. equi*.

V. Fowl Spirochaetosis.

No deliberate research has been carried out on this disease, but with the increasing number of imported poultry in Khartoum isolated outbreaks of the disease are occasionally brought to notice. It has been observed that in imported birds the disease runs a much more acute course than in local stock; it is common for birds that appeared to be quite healthy overnight to be moribund in the morning and to die within a few hours of the first symptoms having been noticed. Whenever possible treatment with Atoxyl has been carried out, but in imported birds the results have not been very good when once the disease has established itself, whereas in half-bred and local stock the results have been excellent. In view of the peracute course the disease runs in imported stock it is suggested that as soon as the first case is microscopically diagnosed all the flock be immediately injected with Atoxyl.

* WILLIAMS, A.J. Report on the treatment of Nuttalliosis or Biliary Fever in army horses at Secunderabad, Deccan India, A.H.Q., Q.M.G's Branch, Simla, 1914. (abst in *Trop. Vet. Bull.* 1916, Vol. 4, p. 8).

VI. Cattle Plague.

Although one of the most serious diseases of the Sudan no research has been carried out on it this year. From the nature of the disease it is necessary that research on it be carried out concurrently with the production of antiserum, and it has been decided that owing to the difficulty of obtaining suitable cattle and the cost of maintaining them, Khartoum is not the best place to institute a serum station. In order to select a suitable site I was instructed by the Director of the Veterinary Department to make a short tour of inspection in the Upper Nile Province in March, and as a result a site was selected for work to be commenced in 1928.

VII. Publications.

During the year the following articles have been published :—

- (i) KNOWLES, R. H. Trypanosomiasis of camels in the Anglo-Egyptian Sudan: Diagnosis, Chemotherapy, Immunity.—*Jl. Comp. Path. and Therap.*, Vol. XL, Part 1, March 1927.
- (ii) BENNETT S. C. J. A note on the nature of the rabies virus in the Anglo - Egyptian Sudan — *Vety. Journal*, Vol. 83. No. 6, June 1927.
- (iii) BENNETT S. C. J. A peculiar equine Sarcosporidium in the Anglo-Egyptian Sudan. — *Vety. Journal* Vol, 83. No. 6, June 1927.
- (iv) KNOWLES, R. H. Contagious bovine pleuro-pneumonia immunisation.—*Jl. Comp. Path. and Therap.*, Vol. XL, Part 3, Sept. 1927.

Conclusion.

In concluding this report one has to thank all field officers of the Veterinary Department for sending material and information. Co-operation on all subjects has been voluntary and unofficial, and one has been impressed with the eagerness of all concerned to help the laboratory on all occasions.

Regarding the more technical side one has to thank other scientific workers in Khartoum for their cordial co-operation in cases where investigations call for wider treatment than can be given to them here. In particular one has to thank the staff of the Wellcome Tropical Research Laboratories to whom no appeal either for loans—which usually become gifts—of material, or for advice on points of more specialised technical questions has ever been made without immediate and willing response.

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